Edition 4.2 EBAF: Surface

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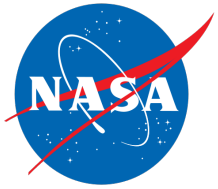


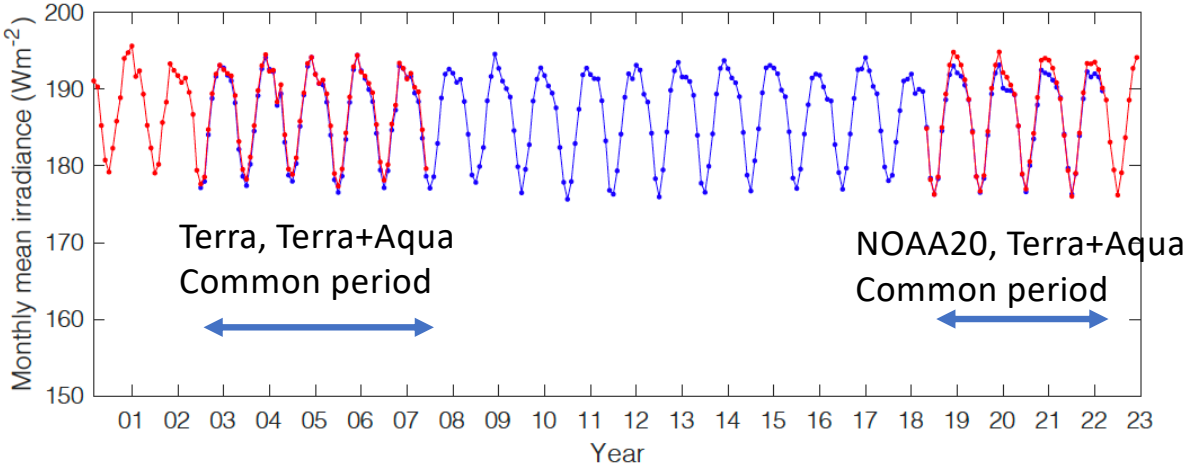
CERES Science Team Meeting
May 9-11, 2023

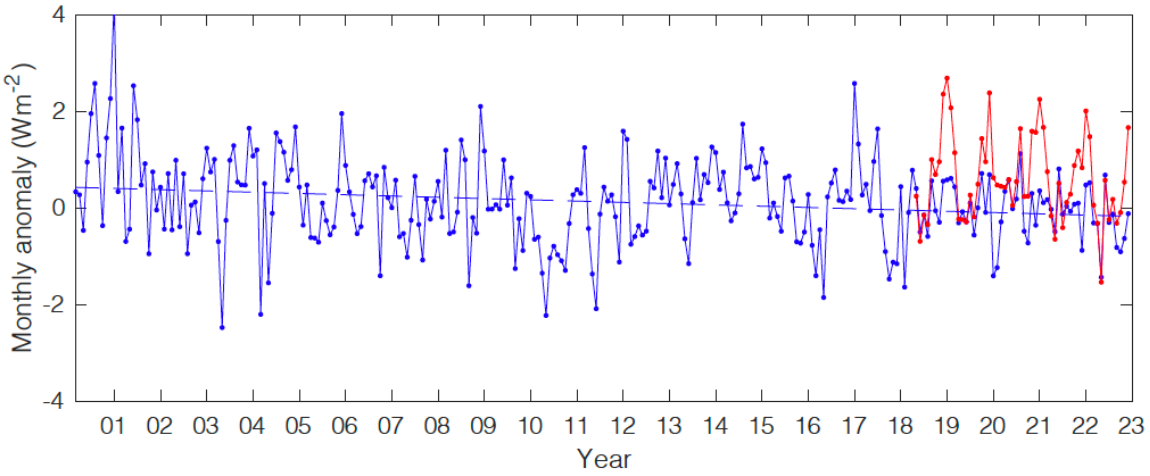
Edition 4.2 algorithm change from Edition 4.1

- Only MODIS and VIIRS retrieved cloud properties are used. (i.e. No cloud properties derived from geostationary satellites is used.)
- MERRA-2 provides temperature and humidity profiles and skin temperature. However, MODIS and VIIRS cloud properties are derived using GEOS-5.4.1.
- Climatological adjustment is applied to Terra only (March 2000 through June 2002) and NOAA20 only (April 2022 onward) periods.
  - Climatologically adjusted flux $\hat{F}_x$ for Terra only and NOAA20 only periods is the Terra+Aqua climatological mean flux + anomalies derived from Terra or NOAA20.

$$\hat{F}_x^t = \bar{F}_x^{ta} + \Delta F_x^t \quad \text{and} \quad \hat{F}_x^{n20} = \bar{F}_x^{ta} + \Delta F_x^{n20}$$

Global monthly mean all-sky surface downward shortwave irradiance





Red:

No climatological adjustment

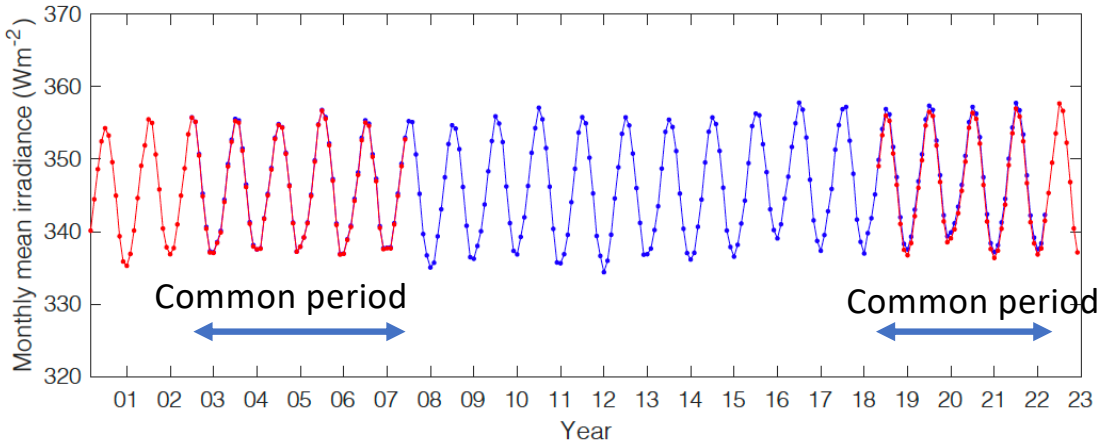
$$\hat{F}_x^{n20} = \bar{F}_x^{n20} + \Delta F_x^{n20}$$
$$= \bar{F}_x^{ta} + [(\bar{F}_x^{n20} - \bar{F}_x^{ta}) + \Delta F_x^{n20}]$$

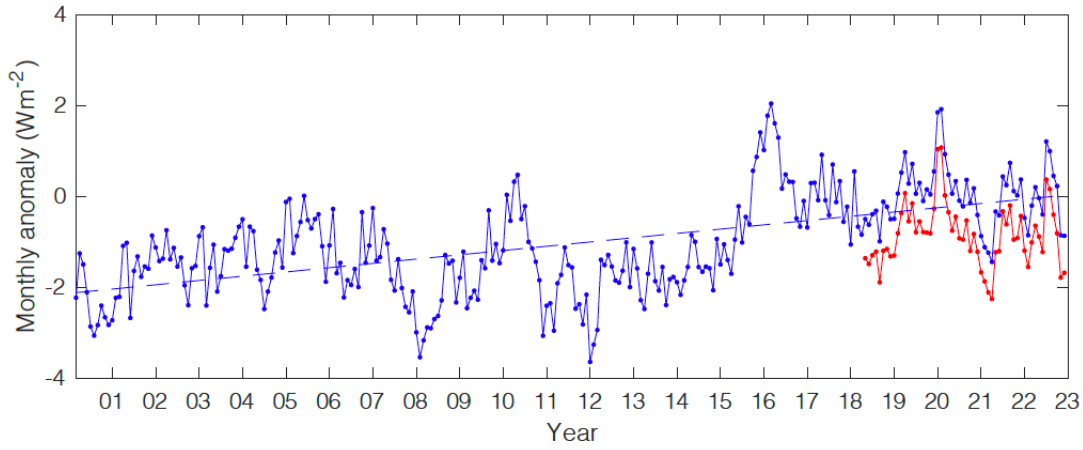
Blue:

Climatological adjustment to NOAA 20 data

$$\hat{F}_x^{n20} = \bar{F}_x^{ta} + \Delta F_x^{n20}$$

Global monthly mean all-sky surface downward longwave irradiance





Red:

No climatological adjustment

$$\hat{F}_x^{n20} = \bar{F}_x^{n20} + \Delta F_x^{n20}$$

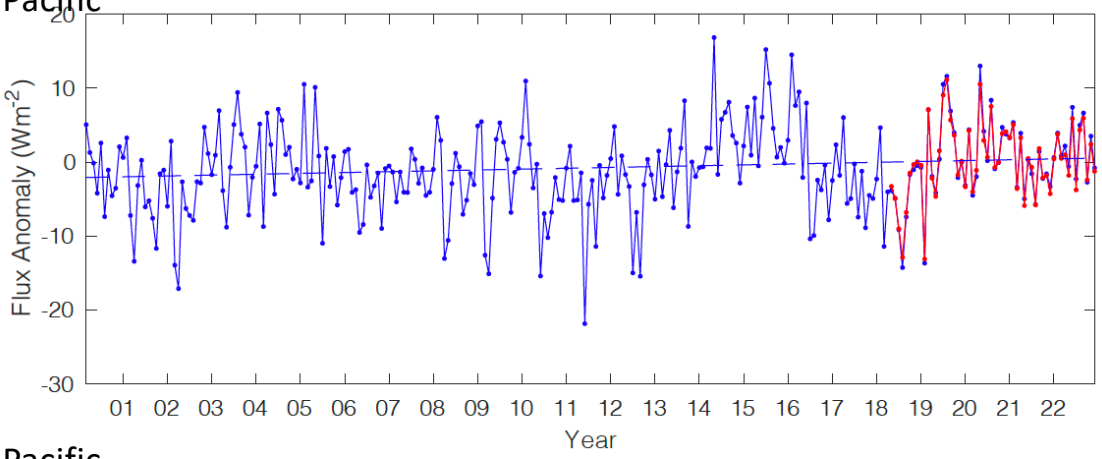
Blue:

Climatological adjustment to NOAA 20 data

$$\hat{F}_x^{n20} = \bar{F}_x^{ta} + \Delta F_x^{n20}$$

Regional downward shortwave irradiance

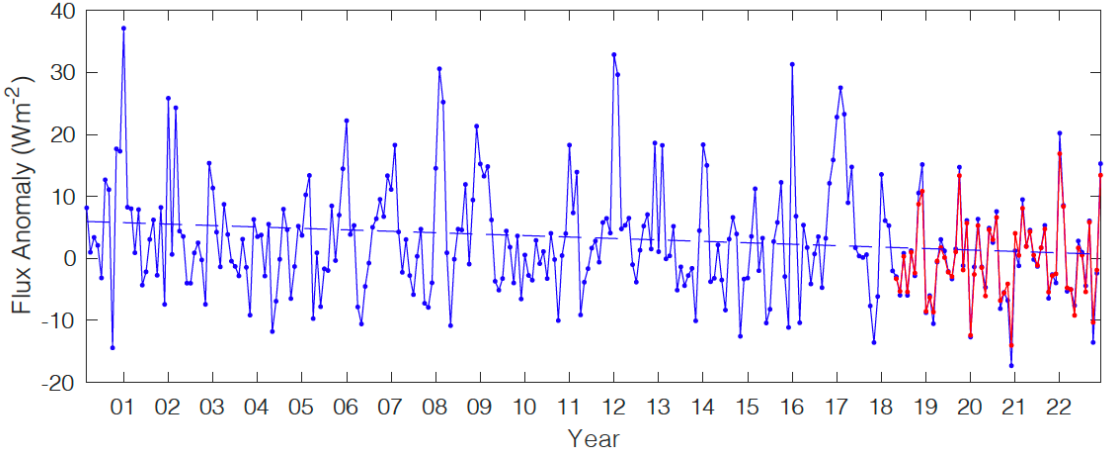
Northeast Pacific

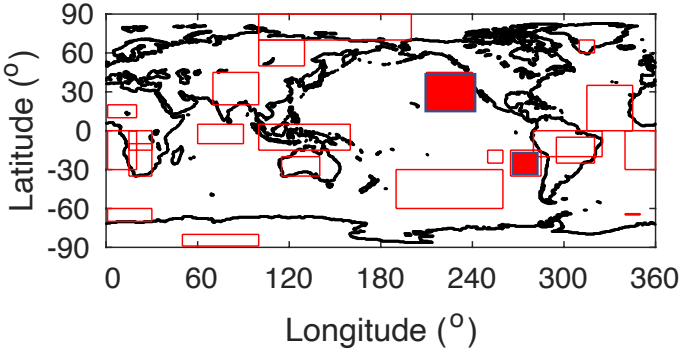


Edition 4.2 EBAF Terra&Terra+Aqua&NOAA20

Edition 4 SYN1deg NOAA20

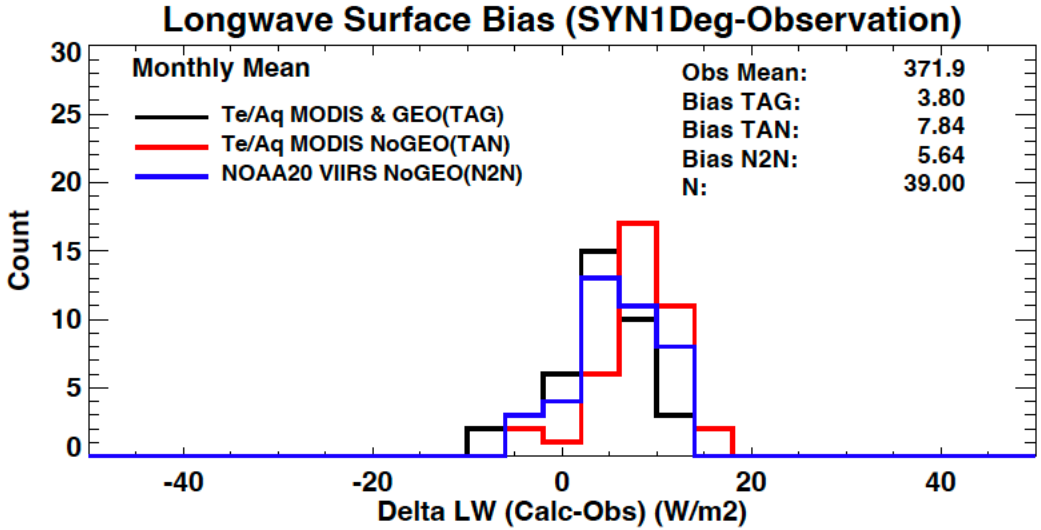
Southeast Pacific

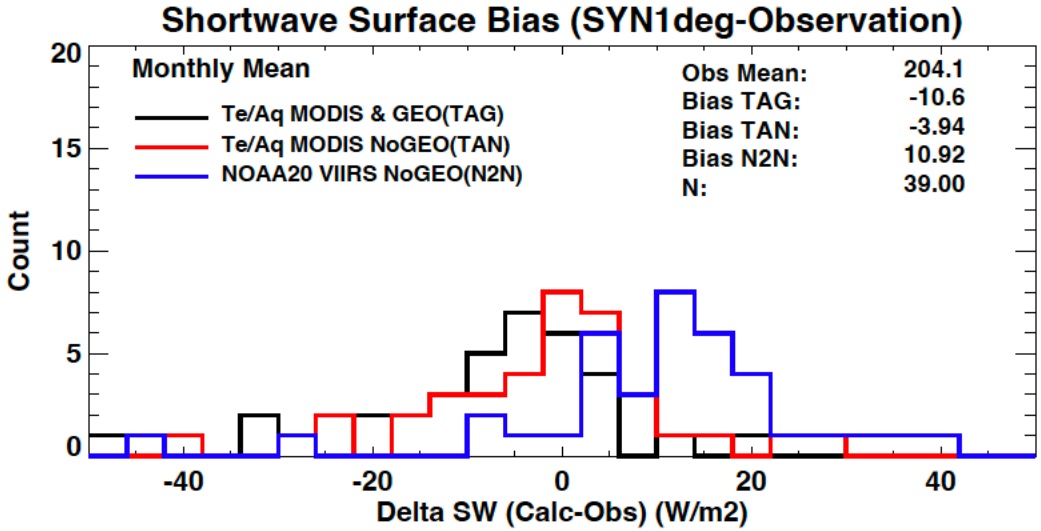




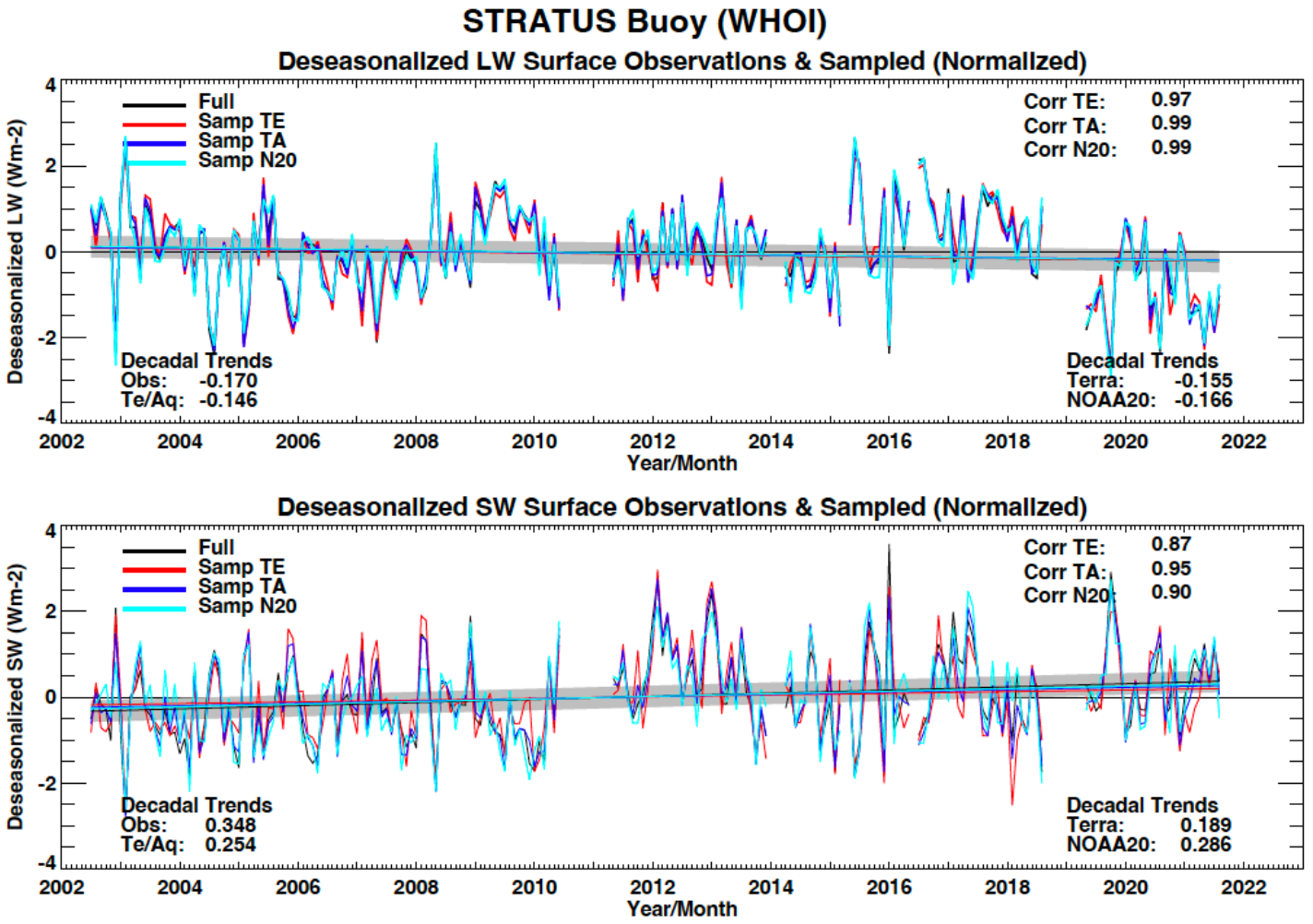
Evaluation of climatological adjustment concept with surface observations

SYN1deg Edition 4 WHOI Stratus buoy data





Full: All observations
TE: Terra overpass time
TA: Terra+Aqua overpass time
N20: NOAA20 overpass time



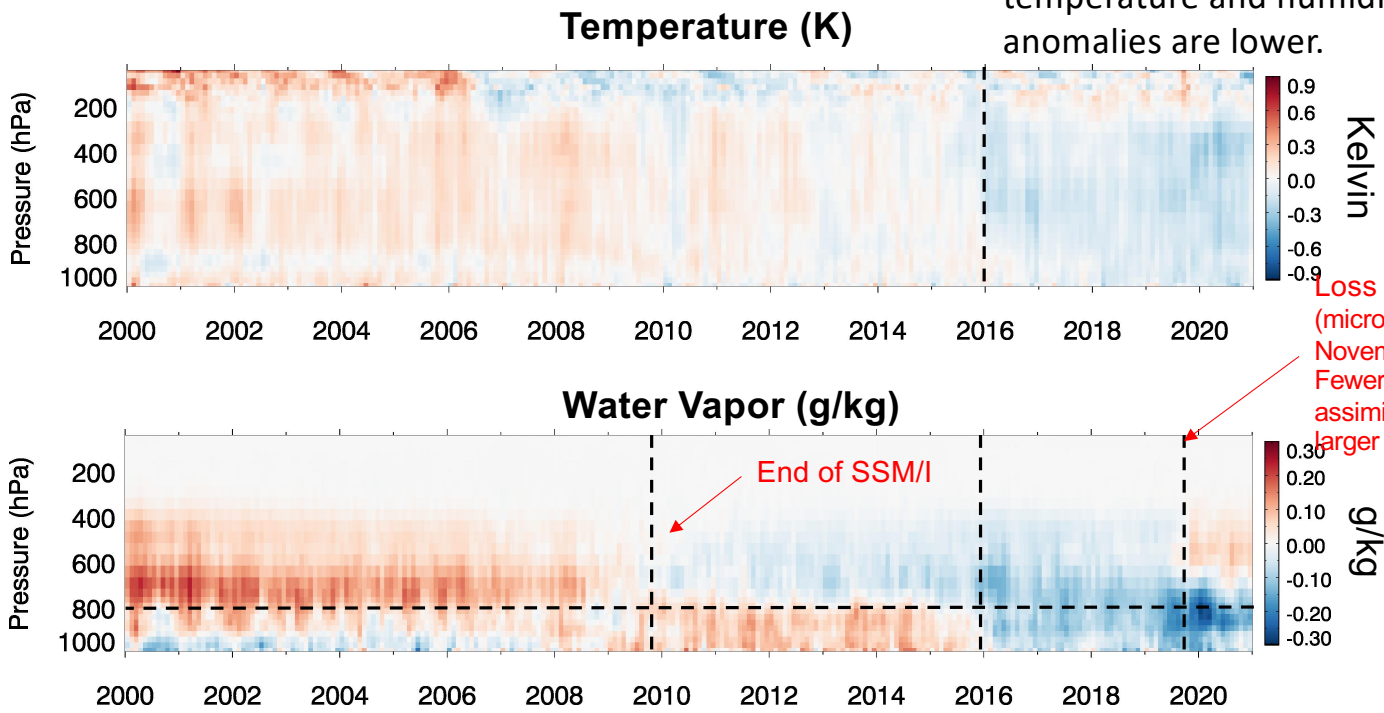
Difference from Edition 4.1

60S-60N Land+Ocean

Area weighted; climatology is obtained using 2003-2020

[G-5.4.1 Anomalies] – [ERA-5 Anomalies]

After 2016, GEOS-5.4.1 temperature and humidity anomalies are lower.



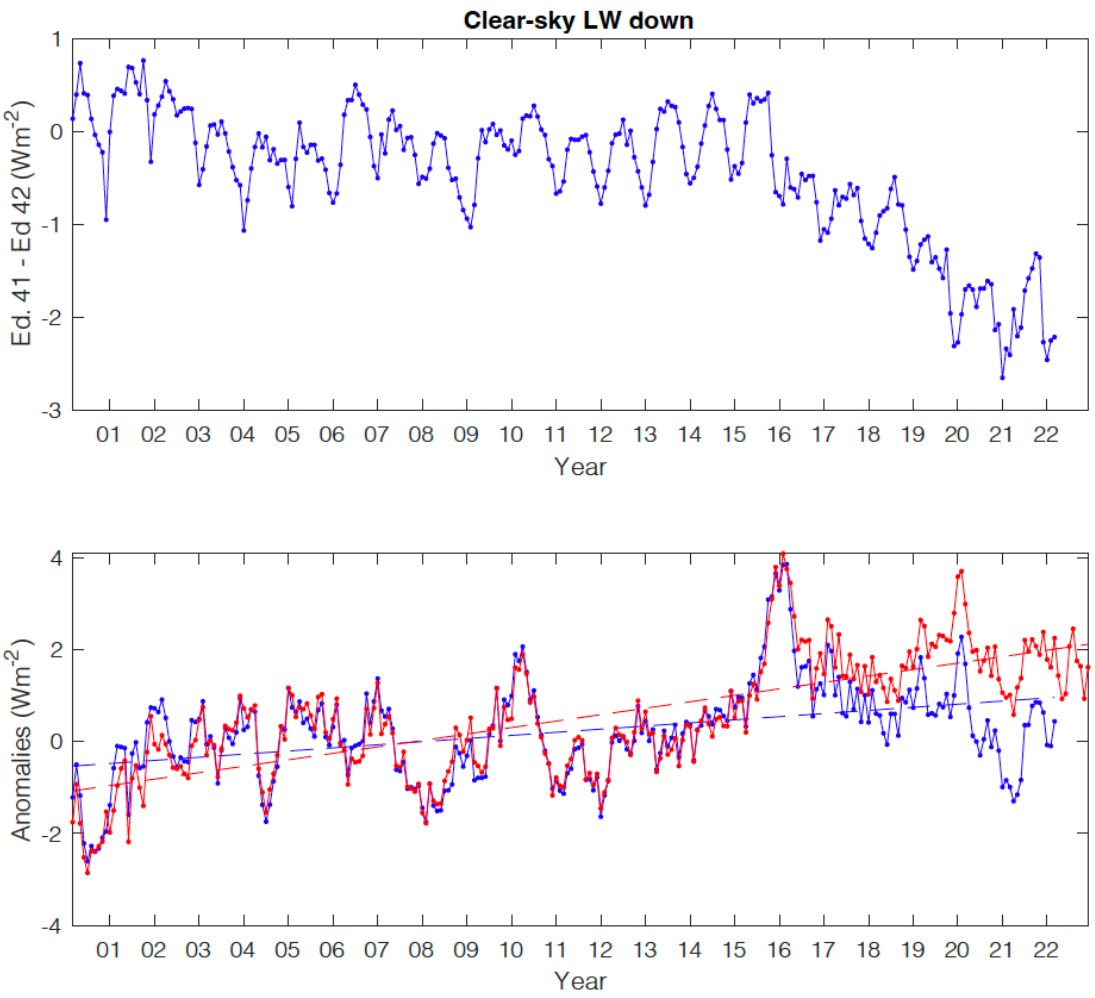
Loss of MHS (microwave humidity sounder) November 2019
Fewer instruments are assimilated so that the impact is larger in GEOS-5.4.1

Tropical standard ATM
Water vapor mixing ratio @ 400 hPa
~0.6 g/kg
~20 to 30% drift

- The differences between G541 and ERA5 are similar to those between G541 and MERRA-2.
- This implies that the differences are mainly driven by G541 problems.

Total area clear-sky downward longwave

(Total area)



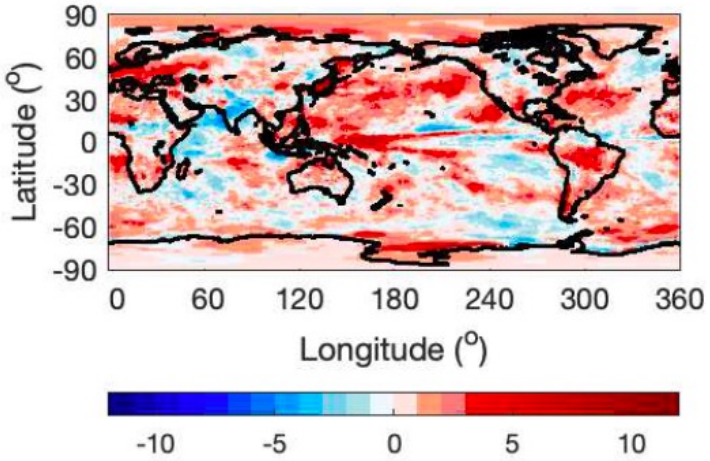
Correction to GEOS-5.4.1 temperature and humidity profiles were made after November 2019.

The effect on the mitigation of MHS loss is limited.

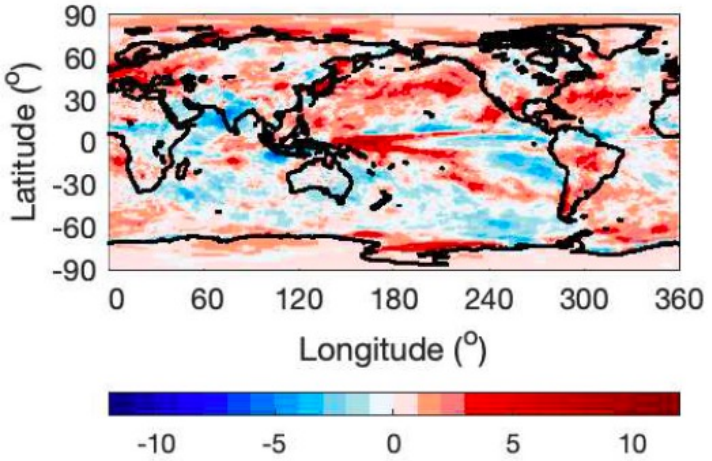
Blue: Edition 4.1
Red: Edition 4.2

Surface shortwave net irradiance trends (Wm^{-2} dec^{-1}) 20003 - 202212

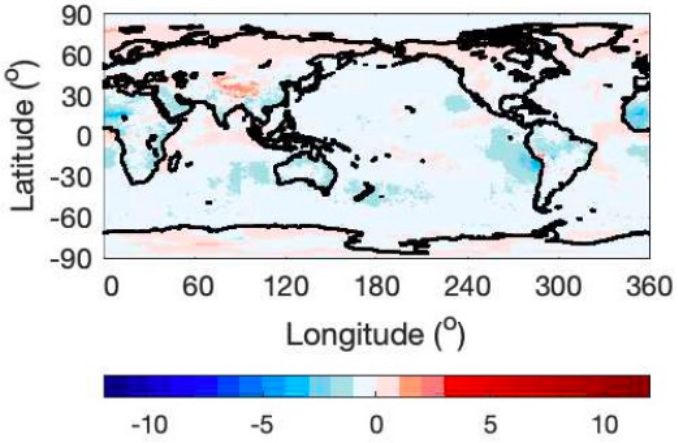
Edition 4.1

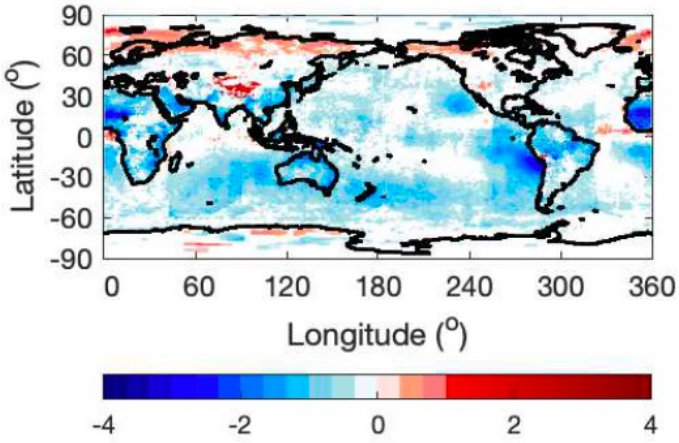


Edition 4.2



Edition 4.2 – Edition 4.1

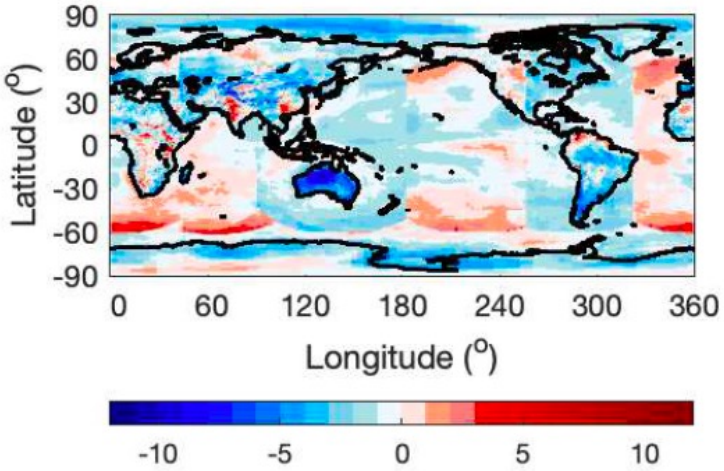


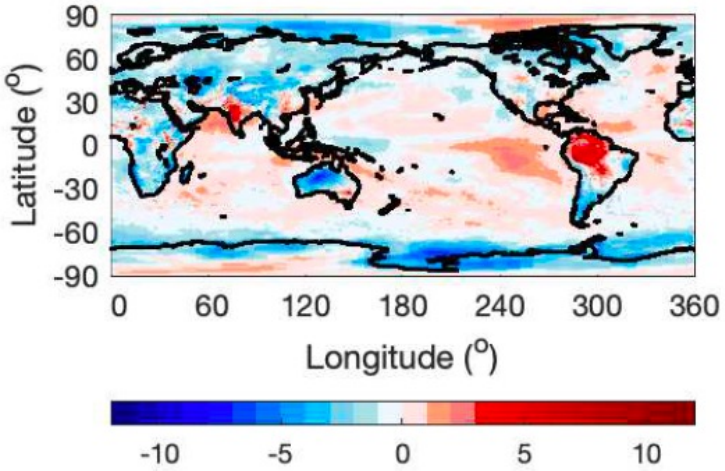


Regions with a difference outside the 5% - 95% confidence interval

Surface longwave net irradiance trends (Wm^{-2} dec^{-1})

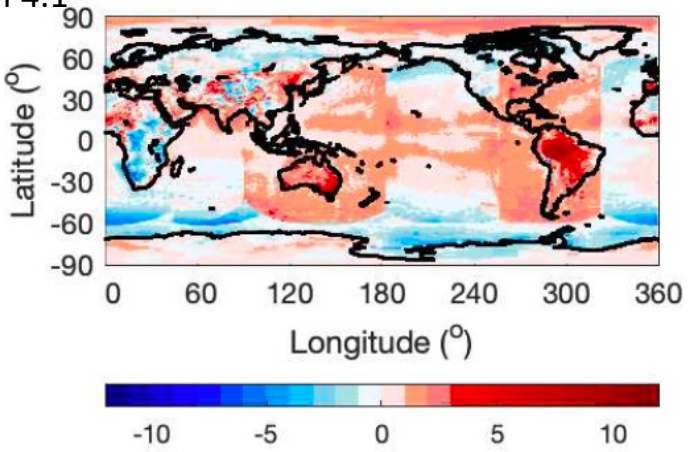
Edition 4.1

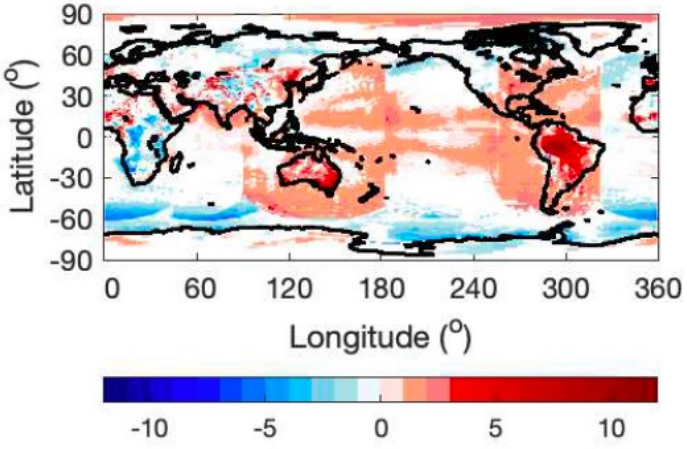




Edition 4.2

Edition 4.2 – Edition 4.1

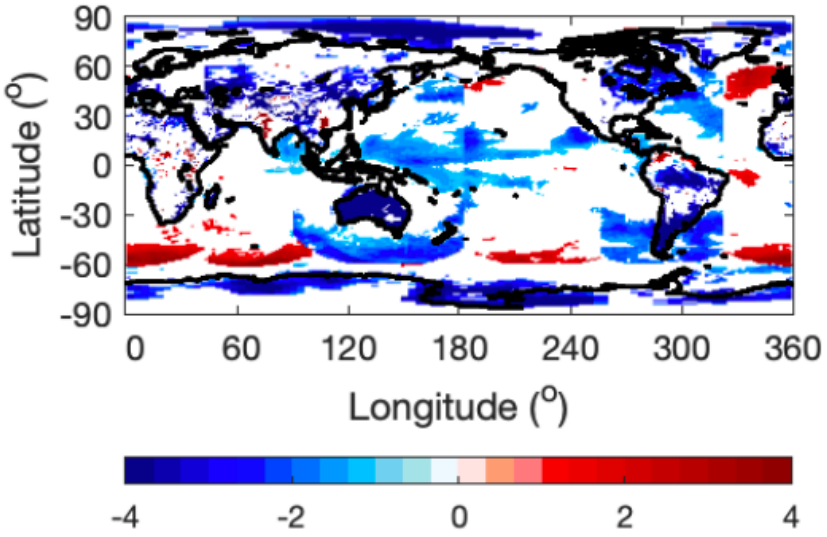




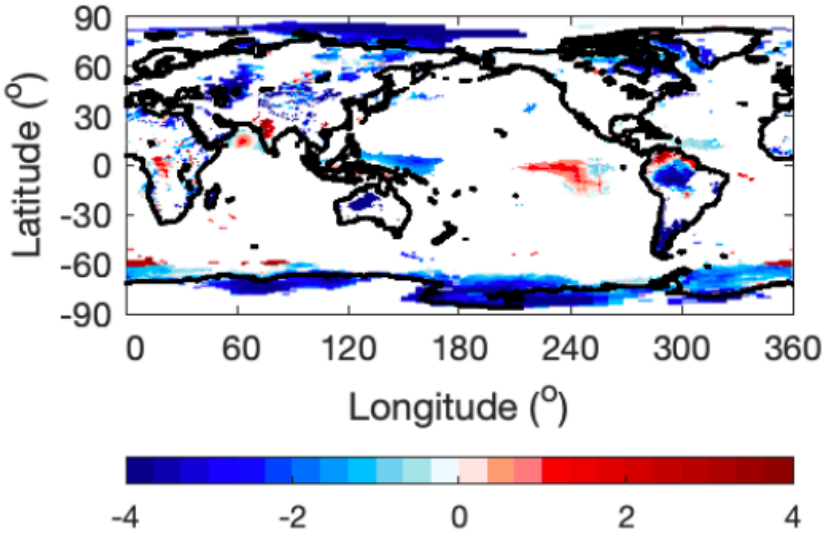
Regions with a difference outside the 5% - 95% confidence interval

Net longwave irradiance trend (Wm^{-2} dec^{-1})

Edition 4.1

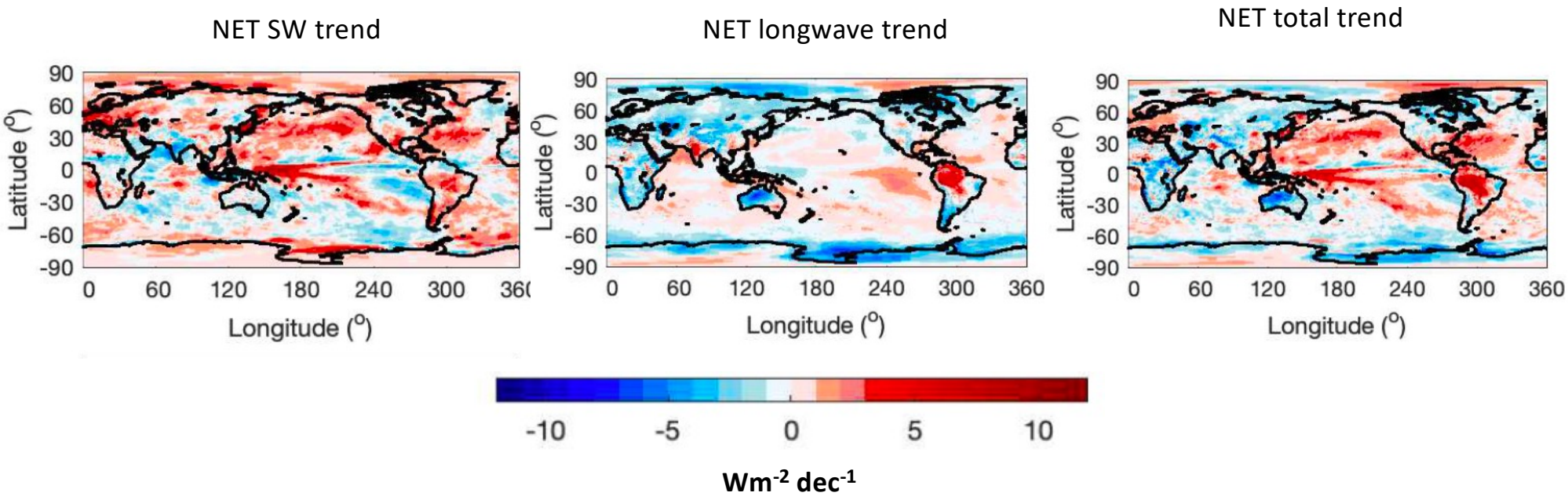


Edition 4.2



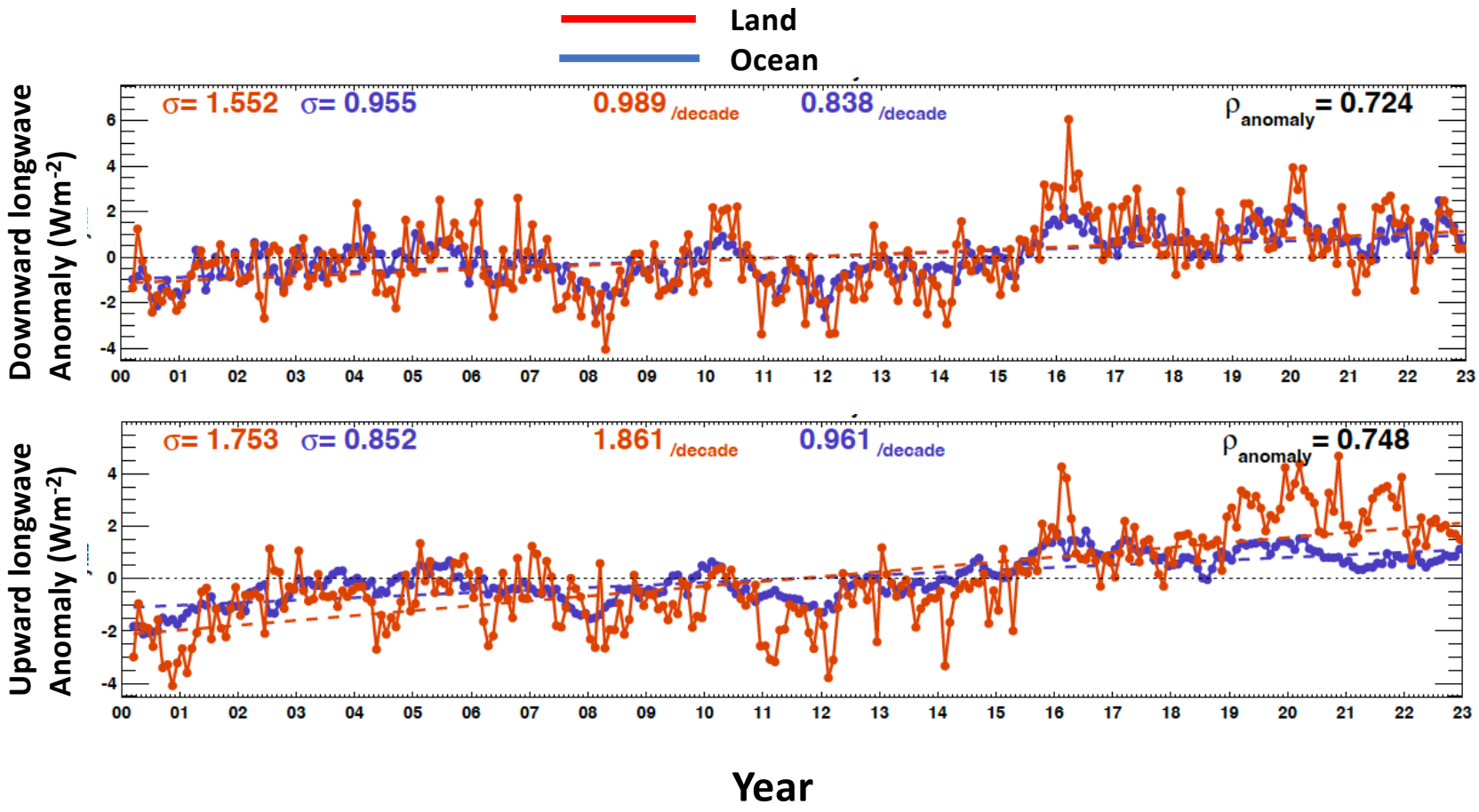
Regions with a trend over March 2000 to December 2022 outside the 5% - 95% confidence interval

Trends of net surface irradiances in the period from March 2000 through December 2022



Ocean trend is dominated by SW and land trend is dominated by LW

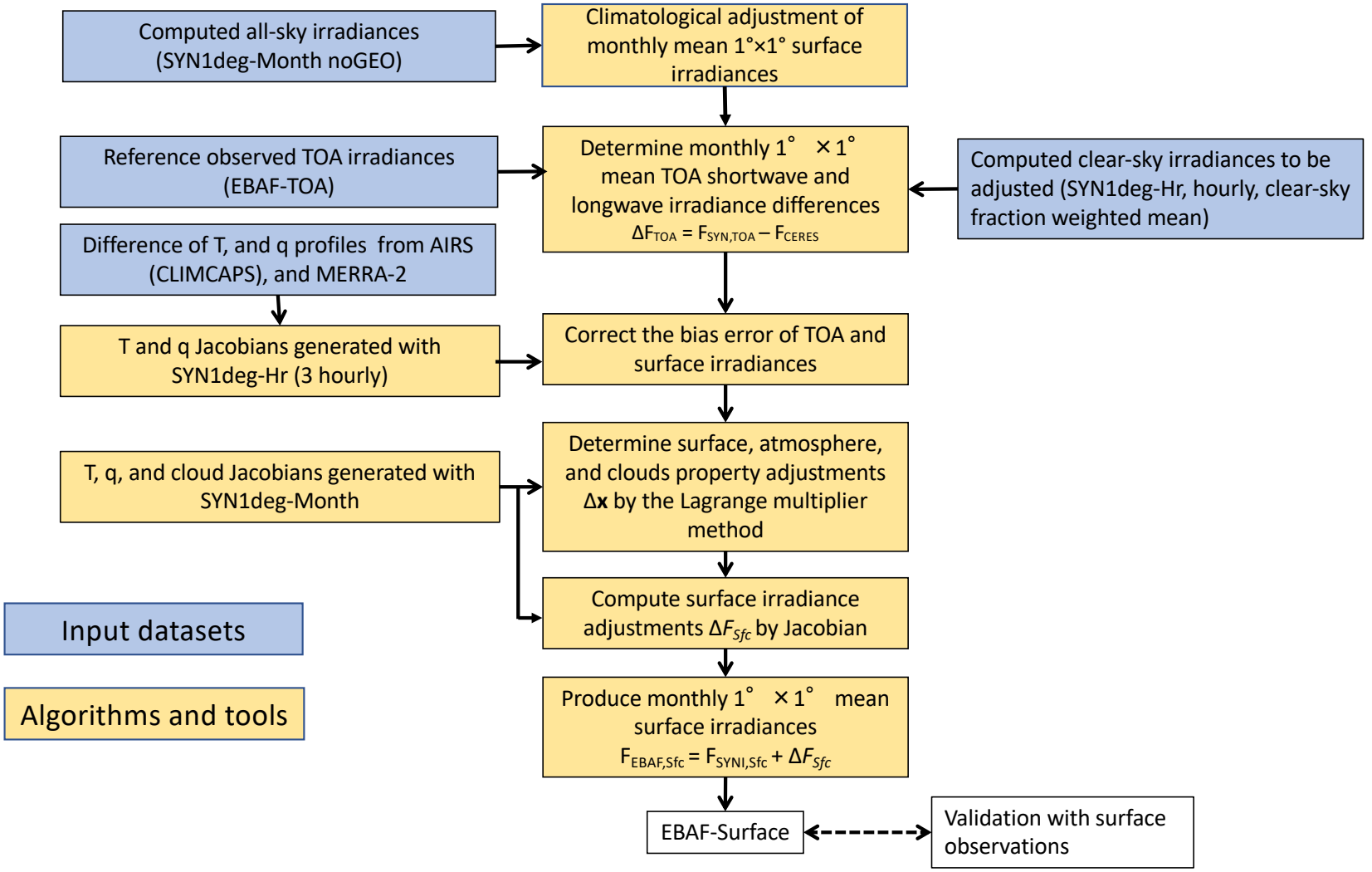
All-sky longwave irradiance trend over land and ocean



Summary

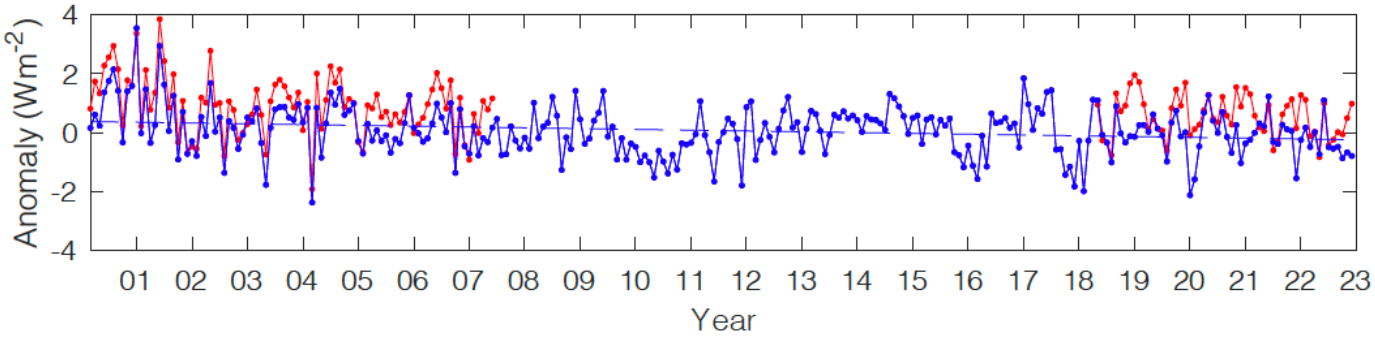
- Surface irradiances for Edition 4.2 EBAF are computed using only MODIS and VIIRS derived cloud properties (i.e. no geostationary satellite derived clouds).
- Cloud properties derived from one orbit (i.e. Terra only or NOAA20 only) are sufficient to derive surface irradiance anomalies.
- Uncertainty in Edition 4.2 surface irradiance anomalies is significantly smaller than the uncertainty in Edition 4.1 surface irradiance anomalies.
- Negative total area clear-sky upward shortwave irradiances occur in both TOA and surface near the boundary of daytime and nighttime.

Back-ups


Computed all-sky irradiances (SYN1deg-Month noGEO)
Climatological adjustment of monthly mean 1°×1° surface irradiances
Reference observed TOA irradiances (EBAF-TOA)
Determine monthly 1° × 1° mean TOA shortwave and longwave irradiance differences
$\Delta F_{TOA} = F_{SYN,TOA} - F_{CERES}$
Computed clear-sky irradiances to be adjusted (SYN1deg-Hr, hourly, clear-sky fraction weighted mean)
Difference of T, and q profiles from AIRS (CLIMCAPS), and MERRA-2
T and q Jacobians generated with SYN1deg-Hr (3 hourly)
Correct the bias error of TOA and surface irradiances
T, q, and cloud Jacobians generated with SYN1deg-Month
Determine surface, atmosphere, and clouds property adjustments Δ**x** by the Lagrange multiplier method
Compute surface irradiance adjustments ΔF_{Sfc} by Jacobian
Produce monthly 1° × 1° mean surface irradiances
$F_{EBAF,Sfc} = F_{SYNI,Sfc} + \Delta F_{Sfc}$
EBAF-Surface
Validation with surface observations
Input datasets
Algorithms and tools

Anomaly time series with and without climatological adjustment: global monthly anomalies

Downward shortwave



Downward longwave